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Empirical modelling of SSUSI derived auroral ionization rates

Stefan Bender[1,2], Patrick Espy[1,2], and Larry Paxton
[1]Norwegian University of Science and Technology, Department of Physics, Physics, Trondheim, Norway
[2]Birkeland Centre for Space Science, Bergen, Norway

Solar, auroral, and radiation belt electrons enter the atmosphere at polar regions leading to ionization and affecting its chemistry. Climate models with interactive chemistry in the upper atmosphere, such as WACCM-X or EDITh, usually parametrize this ionization and calculate the related changes in chemistry based on satellite particle measurements. Precise measurements of the particle and energy influx into the upper atmosphere are difficult because they vary substantially in location and time. Widely used particle data are derived from the POES and GOES satellite measurements which provide electron and proton spectra. These satellites provide in-situ measurements of the particle populations at the satellite altitude, but require interpolation and modelling to infer the actual input into the upper atmosphere.

Here we use the electron energy and flux data products from the Special Sensor Ultraviolet Spectrographic Imager (SSUSI) instruments on board the Defense Meteorological Satellite Program (DMSP) satellites. This formation of currently three operating satellites observes both auroral zones in the far UV from (115--180 nm) with a 3000 km wide swath and 10 x 10 km (nadir) pixel resolution during each orbit. From the N_2 LBH emissions, the precipitating electron energies and fluxes are inferred in the range from 2 keV to 20 keV. We use these observed electron energies and fluxes to calculate auroral ionization rates in the lower thermosphere (≈ 90–150 km), which have been validated previously against ground-based electron density measurements from EISCAT. We present an empirical model of these ionization rates derived for the entire satellite operating time and sorted according to magnetic local time and geomagnetic latitude and longitude. The model is based on geomagnetic and solar flux indices, and a sophisticated noise model is used to account for residual noise correlations. The model will be particularly targeted for use in climate models that include the upper atmosphere, such as the aforementioned WACCM-X or EDITh models. Further applications include the derived conductances in the auroral region, as well as modelling and forecasting E-region disturbances related to Space Weather.